NSLS-II Experimental Tools (NEXT) Progress Report

September 2012

Each month, graphics related to three of the six NEXT beamlines are shown below and discussed in the reports.

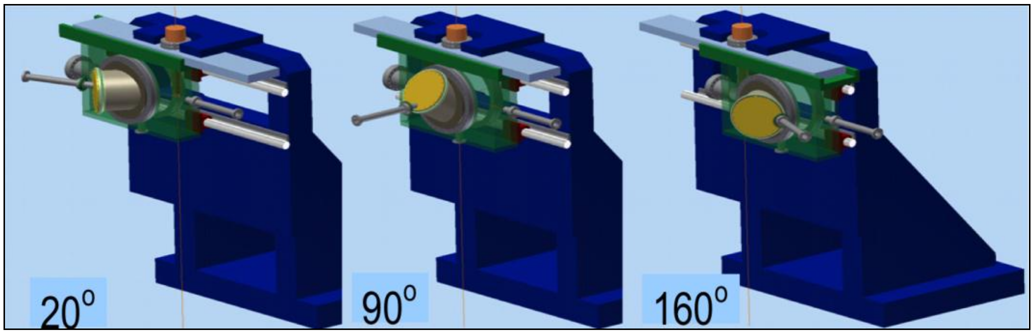
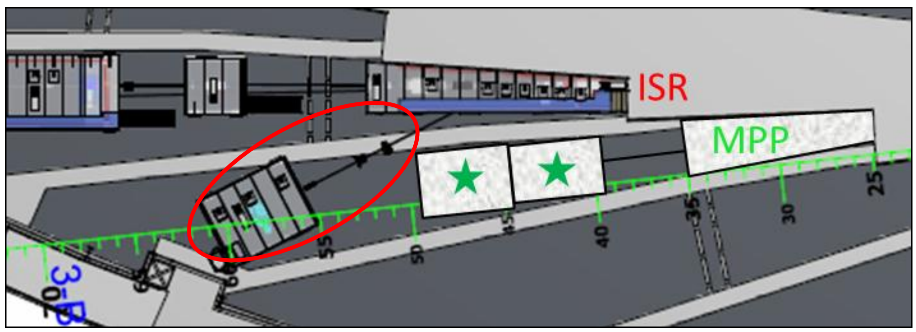


Figure 1. SIX endstation: schematic design of the vacuum coupling between the sample station and the spectrometer arm. Three orientations are shown: a) at the forward scattering position of 2θ = 20 degrees, b) at the midpoint of the angular range, 2θ = 90 degrees, and c) at the back scattering position of 2θ = 160 degrees.

Figure 2. Top-view layout of ISR, showing a schematic layout of a second branch (outlined in red). This branch, a possible future upgrade for ISR, extends onto the floor space of the adjacent 3-pole wiggler beamline. The planned hutch locations of the neighboring beamline, indicated by green stars, are compatible with the ISR second branch beam pipe and hutch locations.



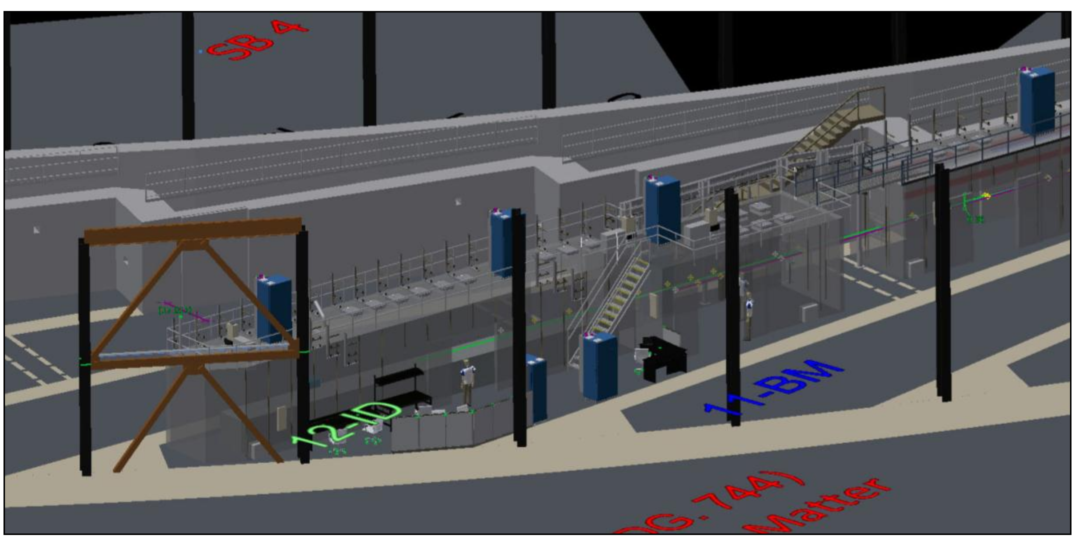


Figure 3. 3D layout of the SMI beamline. Preparation of 2D drawings of the shielded enclosures for specifications requires that the 3D layout on the floor be validated in detail. The foreground of the drawing shows a building girder (brown, at left), that will be close to the wall of the adjacent endstation.

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OVERALL ASSESSMENT

The DOE Office of Project Assessment (OPA) Review of the NEXT Project was held September 11–13 at BNL. The baseline scope presented at this review covers the design of six beamlines and the construction of five beamlines. The proposed total project cost (TPC) of $90M includes $68.1M Budget At Completion (BAC) and 32% contingency. As presented by the review committee at the closeout, the NEXT Project will be ready to request CD-2 approval after the review committee's recommendations are addressed.

Since the September review, the NEXT Project staff concentrated on addressing the review recommendations while continuing preliminary design activities. Basis of estimate and supporting documentation for all Materials & Supplies have been made more complete and clearer to follow, using a consistent naming scheme for the summary supporting document for each M&S item. The obligation profile is also being revised in order to create more built-in schedule float. The beamline scientist positions for four of the five baseline beamlines have been posted, for filling by approximately March 2013.

The Earned Value Management System tracking of NEXT cost and schedule, which began with the May 2012 data, will continue as an internal exercise while the proposed baseline is being finalized.

The fifth mechanical engineering position has been filled, with a start date in November 2012.

SIX – SOFT INELASTIC X-RAY

Following the recommendations of the DOE CD-2 review, we have started to work on a comparative analysis among three possible optical designs for the SIX spectrometer. Our goal is to determine which design may reduce the risks associated with the grazing incidence on the detector, while keeping the specifications in line with the experimental needs. This analysis will be reviewed at our BAT meeting in early October

A schematic design of the novel vacuum coupling between the sample station and the spectrometer arm is shown in Figure 1 (cover). This coupling will provide continuous 140-degree rotation of the spectrometer arm while maintaining ultra-high vacuum.

ISR – IN-SITU AND RESONANT HARD X-RAY

The optical design and layout of ISR, especially the FOE, include accommodation of a second branch, illuminated by a second IVU source in the ISR straight section. A potential layout of this second branch, shown in Figure 2 (cover), does not interfere with the layout of the neighboring 3-pole wiggler beamline The hutch for the second ISR branch can be large enough to accommodate two endstations.

Design refinement is continuing in order to determine the optimal locations of the side-bounce monochromator and the beam pipe that will pass through the outboard wall of the first optics enclosure. A ray tracing analysis covering the entire ISR energy range was completed, using the results from FEA calculations, and full-width-at-half-max spot sizes were determined: ~50 μm (V) x 250 μm (H) at the 4-circle and ~5 μm (V) x 25 μm (H) at the in-situ endstations. These spot size values satisfy the ISR technical requirements.

Finally, schedule refinement was carried out in coordination with preliminary procurement planning. Input from the PS Optics Metrology Group helped determine the optimal grouping of optics procurements, which is now consistent with the ISR baseline schedule.

SMI – SOFT MATTER INTERFACES

SMI is preparing for hutch specifications, which requires scrutiny of the physical layout with realistic details including stairways, cable runs, and other constraints. The procurement requires simple depiction of the hutches with their placements of beam pipes, cable labyrinths, and doors. But preparation of these specs requires that the team examine a detailed 3D rendering. A trip across the street, with hard hats, plumb bobs, and tape measures in hand, revealed an unexpected neighbor, seen in the foreground at left in Figure 3 (cover): the I-beam cross braces vie for space with the endstation wall and support plumbing for a liquid nitrogen drop, which the SMI design must accommodate.

In concert with the 3D model, the SMI team is preparing preliminary front end ray tracing drawings (Fig. 4). This delicate tracery of lines in a 1:200 z:x ratio allows the team to assess shielding constraints that may affect optical component placements, which in turn must be known for the hutch specifications.

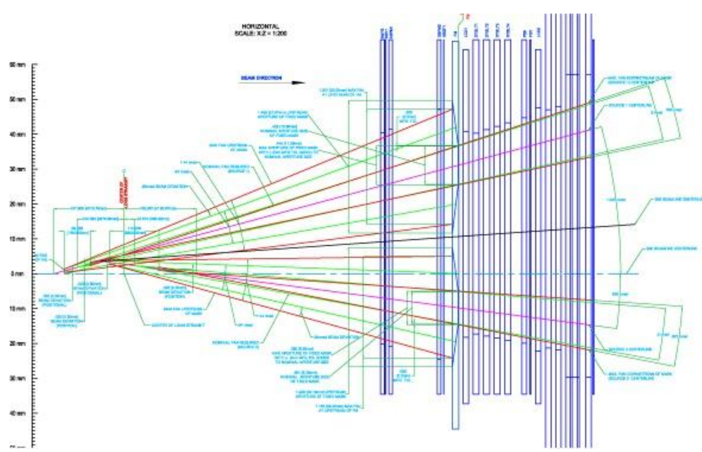


Figure 4: A preliminary bremsstrahlung ray tracing for SMI's canted source layout will ensure that shielding requirements will not affect hutch specifications, as currently designed. Although only one of the SMI sources will be installed in the project scope, rays for both sources are maintained for reference to make sure the upgrade will be feasible.

ISS – INNER SHELL SPECTROSCOPY

The design of the first optical enclosure is nearly finalized, including all infrastructure and wire routing. Detailed planning for the individual work packages that will make up the ISS photon delivery system is in progress. A major milestone of this design process will be a safety and compatibility review, which we plan for the beginning of December. Besides addressing essential safety aspects such as radiation protection, egress procedures, pressure safety, and electrical safety, we will also evaluate our interface documents.

The work on the spectrometer is the second focus of our activities. Reviewers appreciated our proposed risk mitigation: to accompany the design work with measurements and experimental verifications of the component functionality. In September, we not only increased our engineering effort to finalize the design but also purchased various lenses to test the spectrometer feasibility. In addition, we started to collaborate with Konstantin Klementiev (ALBA/Spain), an expert in ray tracing of spectrometers. Besides the characterization capabilities at NSLS we now also have access to beamtime at sector 20 (APS) and sector 26 (ESRF). We expect that a first complete ray trace and first test measurements will be available at the end of November.

FXI – FULL-FIELD X-RAY IMAGING

We started work on the detailed drawings for the shielded enclosures, with emphasis on completing the drawings that are needed to generate a Statement of Work. Based on preliminary ray traces in the FOE, a design for a combined white and pink beam stop that allows the monochromatic beam to pass through has been completed (Fig. 5). The feasibility of this stop is important because it affects the placement of other components in the FOE. The thermal analysis for this beam stop is under consideration.

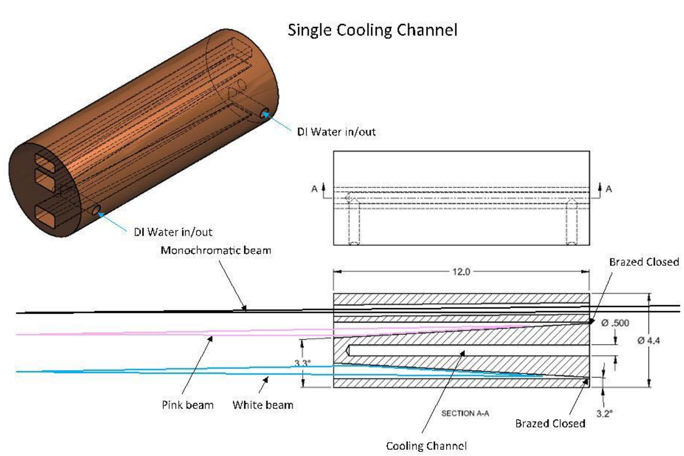


Figure 5: Preliminary design for an integral white and pink beam stop that also allows the monochromatic beam to pass.

ESM – ELECTRON SPECTRO-MICROSCOPY

The effects of the heat deformations induced by the undulator source on the first and second mirrors (M1 and M2) were analyzed, using a combination of FEA calculations and ray tracing analysis. For directly water-cooled mirrors, the deformations are relatively small (see the M1 deformations in the upper part of Fig. 6), implying correspondingly small effects on the x-ray beam. For example, the overall size of the beam at the exit slit of the monochromator changes as reported in the lower part of the figure. Here, the ray tracing includes the effects of thermal deformation of both the first and second mirror surfaces. Note that the mirror deformations are nearly perfectly spherical, implying that after the edge regions of the beam are masked off, the rest of the deformation can be exactly compensated by minor adjustments of the beamline optics (angles and positions).

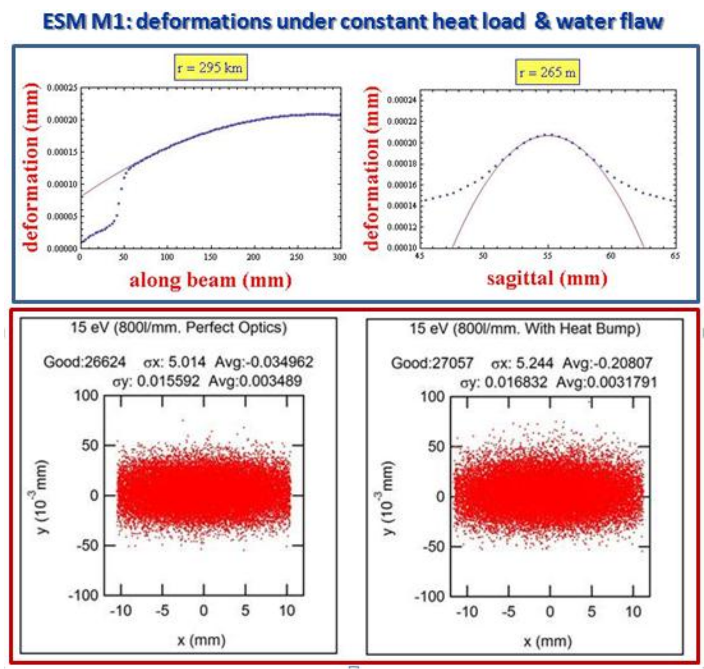


Figure 6: Top panel: M1 mirror deformation (blue curve) along the meridional (left) and sagittal (right) directions. The first derivative of the deformation (green line) shows the thermally induced slope error. Bottom panel: Beam spot at the exit slit of the VLS monochromator, in the case of perfect (left) and thermally deformed M1 and M2 mirror optics.

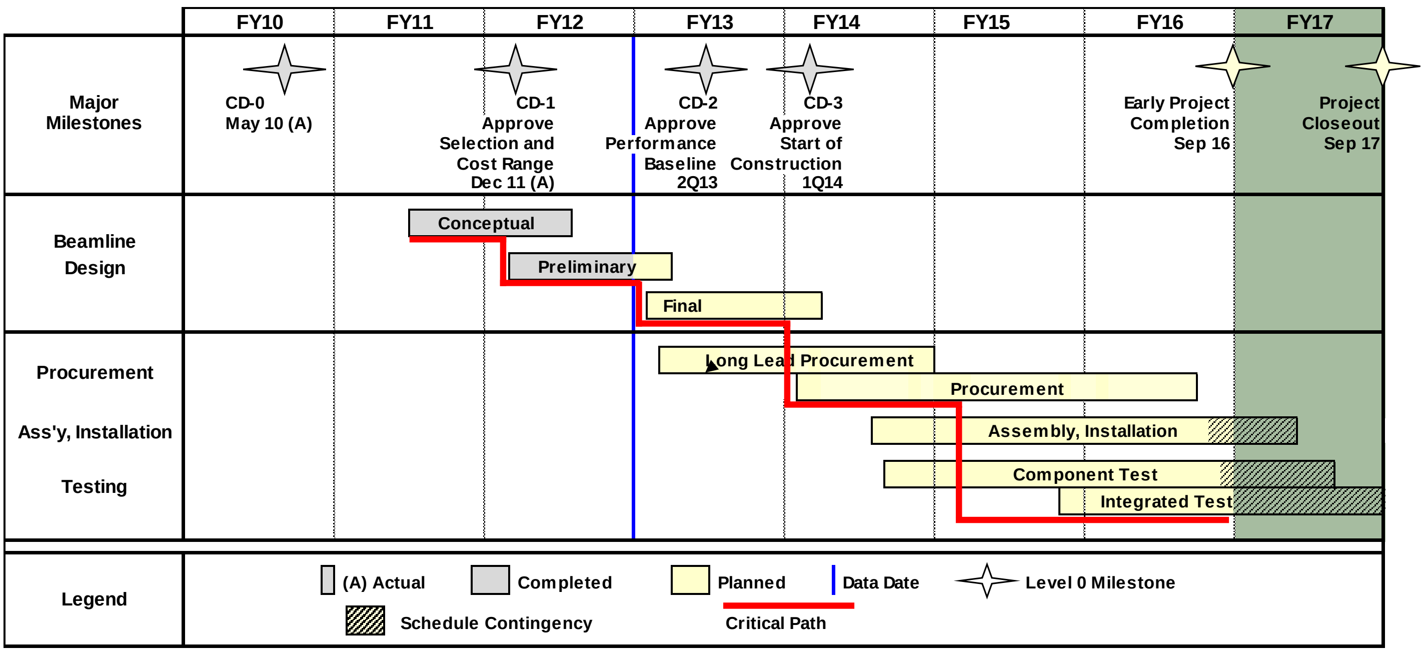
PROJECT MILESTONES

CD-0 (Mission Need):	Planned: 3Q10	Actual: May 27, 2010
CD-1 (Alternative Selection):	Planned: 4Q11	Actual: Dec. 19, 2011
CD-2 (Performance Baseline):	Planned: 2Q13	
CD-3 (Start Construction):	Planned: 1Q14	
Early Project Completion:	Planned: 4Q16	
CD-4 (Project Completion):	Planned: 4Q17	

UPCOMING EVENTS

SIX BAT Meeting	Oct 4
SMI BAT Meeting	Dec 10
ISR BAT Meeting	Dec 13

PROJECT SCHEDULE



Funding Profile

Funding Type	NEXT Funding Profile ($M)						
	FY11	FY12	FY13	FY14	FY15	FY16	TOTAL
OPC	3.0						3.0
TEC		12.0	12.0	25.9	21.6	15.5	87.0
Total Project Cost	3.0	12.0	12.0	25.9	21.6	15.5	90.0

Cost and Staffing Report

	Current Period		Cumulative-to-date	
As of 9/30/2012	Planned*	Actual	Planned*	Actual
Cost	–	$430,999	–	$3,354,796
Staffing (FTE-year)	–	2.04	–	14.84

*Planned values will be included once EVMS tracking has begun.

Key Personnel

Title	Name	Email	Phone
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Glossary of Acronyms

BAC	Budget At Completion
BAT	Beamline Advisory Team
ESM	Electron Spectro-Microscopy (beamline)
EVMS	Earned Value Management System
FEA	Finite Element Analysis
FOE	First Optics Enclosure
FXI	Full-field X-ray Imaging (beamline)
ISR	Integrated In-Situ & Resonant X-Ray Studies (beamline)
ISS	Inner Shell Spectroscopy (beamline)
M&S	Materials and Supplies
MPP	Materials Physics and Processing (beamline)
OPA	Office of Project Assessment
PDR	Preliminary Design Report (or Review)
PSD	Photon Sciences Directorate
SIX	Soft Inelastic X-ray Scattering (beamline)
SMI	Soft Matter Interfaces (beamline)
TPC	Total Project Cost